

Evaluation of Clinical Decision Support Functionality with the Leapfrog CPOE Flight Simulator



Tuesday June 6, 2006

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Can CPOE Cause Errors?



JOBNAME: JAMA.XML PAGE: 1 SESS: 22 OUTPUT: Mon Feb 21 08:12:30 2005
/jama/05jobs/weekly/09mar05/joc42133 DATE: 02/18/05 TIME: 15:29 USER: nsikan

DRAFT

ORIGINAL CONTRIBUTION

Role of Computerized Physician Order Entry Systems in Facilitating Medication Errors

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ADVERSE DRUG EVENTS (ADEs) are estimated to injure or kill more than 77 000 people in hospitals annually.¹ Prescribing errors are the most frequent source.^{2,3} Computerized physician order entry (CPOE) systems are widely

Context: Hospital computerized physician order entry (CPOE) systems are widely regarded as the technical solution to medication ordering errors, the largest identified source of preventable hospital medical error. Published studies report that CPOE reduces medication errors up to 81%. Few researchers, however, have focused on the existence or types of medication errors facilitated by CPOE.

Objective: To identify and quantify the role of CPOE in facilitating prescription error risks.

Design, Setting, and Participants: We performed a qualitative and quantitative study of house staff interaction with a CPOE system at a tertiary-care teaching hospital (2002-2004). We surveyed house staff (N=261; 88% of CPOE users), conducted 5 focus groups and 32 intensive one-on-one interviews with house staff, information technology leaders, pharmacy leaders, attending physicians, and nurses; shadowed house staff and nurses; and observed them using CPOE. Participants included house staff, nurses, and hospital leaders.

Main Outcome Measure: Examples of medication errors caused or exacerbated by the CPOE system.

PEDIATRICS®

Unexpected Increased Mortality After Implementation of a Commercially Sold Computerized Physician Order Entry System

Scott Watson, Trung C. Nguyen, Hülya Bayir and
Richard A. Orr

Yong Y. Han, Joseph A. Carcillo, Shekhar T.
Venkataraman, Robert S.B. Clark, Richard A Orr.

Pediatrics 2005;116;1506-1512

Leapfrog Computer Physician Order Entry (CPOE) Inpatient Standard



Each hospital fulfilling this Leap:

- Assures that prescribers* enter hospital medication orders (75%) via a computer system that includes decision support software to reduce prescribing errors;
- Requires that prescribers electronically document a reason for overriding an interception prior to doing so.
 - ✓* "Prescribers" used throughout this section refers to all clinicians authorized by the hospital to order pharmaceuticals for patients.
- Demonstrates, via a test (now almost complete by the First Consulting Group and the Institute for Safe Medication Practices), that their inpatient CPOE system can alert physicians to at least 50% of common serious prescribing errors. *This criterion for the leap will not count towards your hospital's publicly reported status on this leap until the test is available (January 1, 2007, Limited Release July 2006)*

Leapfrog Ambulatory Standards 2006

- Physician office adopts and uses an electronic system which includes all of the following:
 - Decision support based on drug reference information
 - Decision support which draws from a patient-specific database which includes age, weight, medications prescribed by that office, diagnoses, allergies, specified lab results, and electronically-available formulary information; inclusion of medications prescribed by other physicians is encouraged, but optional
 - Printing of a paper prescription or its NCPDP-compliant electronic transmission to the pharmacy
- Physician office adopts and uses an electronic system which includes all of the following:
 - Tracking whether results have been reviewed by the practice
 - Tracking whether results have been communicated to the patient, either electronically or via telephone or regular mail
 - Storage and retrieval of LOINC-compliant lab results reports (excepting microbiology) in database-structured format
- Physician office adopts and uses an electronic system which includes all of the following:
 - Patient-specific database which includes age, gender, diagnoses, treatment codes, lab test results, and medications documented by a clinician, AND
 - Specified reminders for clinicians drawn from current US Preventive Services Task Force and other nationally recognized care guidelines (Appendix B)



Leapfrog CPOE Flight Simulator



CPOE Standard Evaluation Methodology

Description of Order Categories



Order Category	Description	Examples
Therapeutic duplication	Medication with therapeutic overlap with another new or active order; may be same drug, within drug class, or involve components of combination products	Codeine AND Tylenol #3
Single and cumulative dose limits	Medication with a specified dose that exceeds recommended dose ranges or that will result in a cumulative dose that exceeds recommended ranges	Ten-fold excess dose of Methotrexate
Allergies and cross-allergies	Medication for which patient allergy has been documented or allergy to other drug in same category has been documented	Penicillin prescribed for patient with documented Penicillin allergy
Contraindicated route of administration	Order specifying a route of administration (e.g., oral, intramuscular, intravenous) not appropriate for the identified medication	Tylenol to be administered intravenously
Drug-drug interaction	Medication that results in known, dangerous interaction when administered in combination with a different medication in a new or existing order for the patient	Digoxin AND Quinidine
Contraindication / dose limits based on patient diagnosis	Medication either contraindicated based on patient diagnosis or diagnosis affects appropriate dosing	Nonspecific beta blocker in patient with asthma

CPOE Standard Evaluation Methodology

Description of Order Categories (cont)



Order Category	Description	Examples
Contraindication dose limits based on patient age and weight	Medication either contraindicated for this patient based on age and weight or for which age and weight must be considered in appropriate dosing	Adult dose of antibiotic in a newborn
Contraindication / dose limits based on laboratory studies	Medication either contraindicated for this patient based on laboratory studies or for which relevant laboratory results must be considered in appropriate dosing	Normal adult dose regimen of renally eliminated medication in patient with elevated creatinine
Contraindication / dose limits based on radiology studies	Medication contraindicated for this patient based on interaction with contrast medium in recent or ordered radiology study	Medication prescribed known to interact with contrast medium in ordered head CT exam
Corollary	Intervention that requires an associated or secondary order to meet the standard of care	Prompt to order drug levels when ordering Dilantin
Cost of Care	Test that duplicates a service within a timeframe in which there is typically minimal benefits from repeating the test	Repeat test for Digoxin level within 2 hours
Nuisance	Order with such a mild or typically inconsequential interaction that clinicians typically ignore the advice provided	Lasix AND Digoxin in patient with normal potassium

Leapfrog Ambulatory EHR Standard

2006 Appendix B: Specified Reminders



- CAD:
 - Aspirin and beta blocker use
 - Lipid measurement/management
 - ACE inhibitor after MI if evidence of systolic dysfunction
- Diabetes:
 - HbA1C measurement/management
 - Lipid measurement/management
 - Aspirin and ACE inhibitor use
 - Eye examination
 - Foot exams
- Cerebrovascular Disease
 - Warfarin use in atrial fibrillation
- Prevention:
 - Adult immunizations (Flu, pneumonia, and Td)
 - Pediatric immunizations (non-Medicare measure)
- CHF:
 - ACE inhibitor use
 - Documentation of systolic function measurement
 - Breast cancer screening
 - PAP smears
 - Colorectal cancer screening
 - Foot exams



Welcome to the Leapfrog Computerized Physician Order Entry (CPOE) Web-based evaluation. The CPOE Evaluation is a remote test for use by hospitals and ambulatory care offices to assess their compliance with The Leapfrog Group's CPOE and ambulatory standards.

The overarching goal is to assist
The Leapfrog Group in its nationwide effort to
improve patient safety.

If you are already a member, Sign in here

Hospital ID:
Security Code:
User Name:
Password:
 [Forgot password?](#)

Only member hospitals and ambulatory care offices can take the CPOE evaluation test. To become a member, please contact the Administrator at ###-###-#### to obtain an ID and security code. You should receive a security code via e-mail within two business days. If you have any questions, please call The MedStat Group at (734) 913-3333.

- You must use your security code to gain access to the CPOE Test instructions, content, and to submit your responses to the CPOE questions and test.
- For multi-hospital systems, each hospital will need to obtain its own unique ID and security code.

Note: This application loads properly only in Internet Explorer.

Select Evaluation Type



CPOE Evaluation Application - Microsoft Internet Explorer

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Address http://61.14.8.113/leapfrog/user/downloadpatient.asp?OrgType= Go Links

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To begin the CPOE Test, you first must obtain the patient descriptions (criteria) that must be programmed into your ADT, Laboratory, and CPOE applications as appropriate. Once you download the patient descriptions, you will have up to **four hours** to print the patient description list, program the patient descriptions into the appropriate applications in your CPOE production or mirrored production environment, return to this site and download the order set for testing.

Please select CPOE Evaluation Type:
This field will determine the type of CPOE Test that you will receive.
You can only select one type at a time.

Select one
Select one
Pediatric inpatient
Adult ambulatory

Download Patients

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Internet

Obtain Patient Descriptions



CPOE Evaluation Application - Microsoft Internet Explorer

Address: <http://61.14.8.113/leapfrog/user/downloadpatient.asp>

Patient Id	Age	Sex	Weight	Allergies	Diagnosis/Problems	Lab Values	Specifics
9	90 years	Male		Allergies	Dementia		
10	49 years	Female	75Kg, 175 cm	No Known Drug Allergies Peanut Allergy	Chronic Obstructive Pulmonary Disease	Theophylline level = 15 mg/L Potassium = 4.0 mEq/L	none
11	17 years	Female	45Kg	No Known Drug Allergies	Acne		

Health Maintenance Component

Patient Id	Age	Sex	Weight	Allergies	Diagnosis/Problems	Lab Values	Specifics
HM1	68 years	Female	90 Kg	No Known Drug Allergies	Coronary Artery Disease(CAD), S/P Myocardial Infarction	Last LDL-C = 120, HDL-C = 30; 18 months ago	No current medications on Medication List
HM2	67 years	Male	100 Kg	No Known Drug Allergies	Adult Onset	Last LDLC = 130, Last HDLC = 28; 18 months ago	No Hemoglobin A1C documented, Last dilated eye exam 18 months ago (health maintenance)
HM3	81 years					none	No Medication on Medication List
HM4	67 years	Male	60 Kg	No Known Drug Allergies	Chronic Obstructive Pulmonary Disease	Last Influenza Vaccine 3 years ago, Last tetanus Vaccine 25 years ago	No History of Pneumococcal vaccine
HM5	55 years	Female	100 Kg	No Known Drug Allergies	Obesity	Last Mammogram 5 years ago, Last Pap Smear 5 years ago	No History of Flexible sigmoidoscopy or colonoscopy

Once you print the Patient Descriptions, please **log out** and enter the descriptions into your production or mirrored production environment. When you are finished, return to this site, log in and download the orders.

[Sign out](#)

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Done Internet

Download Orders and Worksheet



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Address http://61.14.8.113/leapfrog/user/downloadorders.asp Go Links

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Please print the orders shown below and enter the orders into your CPOE application for the appropriate patients. Record the results of each order including the alert message then return to this site to submit the results.

Print Orders

Number	Order	Patient	Result (Check One)
1	Levothroid 200 mcg po twice daily	1	<input type="checkbox"/> Alert or Information Received or Order Blocked.DisPlayed Message: _____ <input type="checkbox"/> Order Accepted, No Alert or Information Received <input type="checkbox"/> Medication Not on Formulary
2	Cephalexin 250 mg po four times a day	1	<input type="checkbox"/> Alert or Information Received or Order Blocked.DisPlayed Message: _____ <input type="checkbox"/> Order Accepted, No Alert or Information Received <input type="checkbox"/> Medication Not on Formulary
3	Lovenox 80 mg subcutaneous every 12 hours	1	<input type="checkbox"/> Alert or Information Received or Order Blocked.DisPlayed Message: _____ <input type="checkbox"/> Order Accepted, No Alert or Information Received <input type="checkbox"/> Medication Not on Formulary
4	Demerol 50 mg po every 4 to 6 hours as needed	1	<input type="checkbox"/> Alert or Information Received or Order Blocked.DisPlayed Message: _____ <input type="checkbox"/> Order Accepted, No Alert or Information Received <input type="checkbox"/> Medication Not on Formulary
5	1) Metoprolol 50 mg po twice daily; 2) Toprol XL 100 mg po daily	2	<input type="checkbox"/> Alert or Information Received or Order Blocked.DisPlayed Message: _____ <input type="checkbox"/> Order Accepted, No Alert or Information Received <input type="checkbox"/> Medication Not on Formulary
6	1) Lotrel 5 mg/10 mg po daily; 2) Enalapril 5 mg po daily	2	<input type="checkbox"/> Alert or Information Received or Order Blocked.DisPlayed Message: _____ <input type="checkbox"/> Order Accepted, No Alert or Information Received <input type="checkbox"/> Medication Not on Formulary
7	Hydrocodone/Acetaminophen 5 mg/500 mg (Vicodin) 2 tablets po every four hours	2	<input type="checkbox"/> Alert or Information Received or Order Blocked.DisPlayed Message: _____ <input type="checkbox"/> Order Accepted, No Alert or Information Received <input type="checkbox"/> Medication Not on Formulary
8	Vicodin ES one tablet every 6 hoursTylenol 500mg po every 4 hours prn	2	<input type="checkbox"/> Alert or Information Received or Order Blocked.DisPlayed Message: _____

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Download Health Maintenance Worksheet



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HM4

☐ TB
☐ None of the above

HM5

☐ Aspirin Use
☐ Beta Blocker Use
☐ Ace Inhibitor Use
☐ Influenza (Flu Vaccine)
☐ Pneumovax
☐ Tetanus (Td)
☐ MMR
☐ DTaP
☐ Papanicolaou (Pap) Screening
☐ Mammography Screening
☐ Colorectal Screening
☐ Syphilis Screening
☐ Lipid Measurement / Management
☐ Scheduling of periodic INRs
☐ HbA1C Measurement / Management

☐ Influenza (Flu Vaccine)
☐ Pneumovax
☐ Tetanus (Td)
☐ MMR
☐ DTaP
☐ Papanicolaou (Pap) Screening
☐ Mammography Screening
☐ Colorectal Screening
☐ Syphilis Screening
☐ Lipid Measurement / Management
☐ Scheduling of periodic INRs
☐ HbA1C Measurement / Management
☐ Ophthalmology Exam
☐ TB
☐ None of the above

Sign out

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start CPOE Evaluation Appl... Microsoft PowerPoint ... Internet 1:35 PM

Microsoft Internet Explorer

You will have TWO hours to return to this site and submit the results.

OK

Submit Responses



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You are now ready to submit your responses for the medication order entry portion. Please take your time and carefully enter your responses. **Only one result per order can be entered.** Once you have completed entering all results, click on the bottom of this page to record your results. Next you will be taken to the health maintenance component to record those results.

Number	Order	Result
1	Levothroid 200 mcg po twice daily	<input type="radio"/> Received advice or information on medication dose limits <input type="radio"/> Placed order and did not receive advice or information on medication dose limits <input type="radio"/> Medication Not on Formulary
2	Cephalexin 250 mg po four times a day	<input type="radio"/> Received advice or information on allergies to medication <input type="radio"/> Placed order and did not receive advice or information on allergies to medication <input type="radio"/> Medication Not on Formulary
3	Lovenox 80 mg subcutaneous every 12 hours	<input type="radio"/> Received advice or information on patient age or medication dose adjustment <input type="radio"/> Placed order and did not receive advice or information on patient age or medication dose adjustment <input type="radio"/> Medication Not on Formulary
4	Demerol 50 mg po every 4 to 6 hours as needed	<input type="radio"/> Received advice or information on drug:diagnosis interactions <input type="radio"/> Placed order and did not receive advice or information drug:diagnosis interactions <input type="radio"/> Medication Not on Formulary
		<input type="radio"/> Received advice or information on therapeutic duplication

Submit HM Responses



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Back Forward Stop Home Search Favorites Print Mail Address http://61.14.8.113/leapfrog/user/SubmitHealthInfo.asp?Aid={568B2CCE-81C1-442F-9871-B11CC0FBEBF7}&PatientTypeID=3 Go Links

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You are now ready to submit your responses for the health maintenance component. Please take your time and carefully enter your responses. **Multiple results per patient can be entered.** Once you have completed entering all results, click on the bottom of this page to record your results. Next you will be taken to the display score page.

Note: Hold Shift key for multiple contiguous entries. Hold the Ctrl key to select non-contiguous entries

Preventive Patient ID	Reminders
HM1	Aspirin Use Beta Blocker Use Ace Inhibitor Use Influenza (Flu Vaccine) Pneumovax
HM2	Aspirin Use Beta Blocker Use Ace Inhibitor Use Influenza (Flu Vaccine) Pneumovax
HM3	Aspirin Use Beta Blocker Use Ace Inhibitor Use Influenza (Flu Vaccine) Pneumovax
HM4	Aspirin Use Beta Blocker Use Ace Inhibitor Use Influenza (Flu Vaccine) Pneumovax
HM5	Aspirin Use Beta Blocker Use Ace Inhibitor Use Influenza (Flu Vaccine) Pneumovax

Submit Results

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Done Internet

View Results



http://61.14.8.113/leapfrog/user/SumitHealthResults.asp?Count=5 - Microsoft Internet Explorer

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Medication Checking	Score (in percent)	Health Maintenance Checking	Score (in percent)
Therapeutic Duplication	88.00	Sensitivity	24 %
Single and Cumulative Dose Limits	14.00	Specificity	85 %
Allergies and Cross Allergies	67.00	Accuracy	73 %
Drug:Drug interactions	50.00		
Drug:Diagnosis interactions	100.00		
Contraindication / Dose Limits Based on Age and Weight	64.00		
Contraindication / Dose Limits Based on Laboratory Studies	33.00		
Corollary Orders	50.00		
Deception Analysis	33.00		
Nuisance Orders	100.00		

Your TOTAL score reflects:

 Medication Checking: Good progress in implementing recommended safety practice

Note: Medication checking Total score does not include Nuisance and Deception Analysis categories

Legend	Description
	Did not meet criteria for a good early stage effort
	Good early stage effort in implementing recommended safety practice
	Good progress in implementing recommended safety practice
	Fully implemented recommended safety practice
	Did not complete the evaluation or did not report results

*The order entry system accepted the following order(s) that could have caused severe harm:

Category	Order Description
Single and Cumulative Dose Limits	Vicodin ES one tablet every 6 hours Tylenol 500mg po every 4 hours prn

FOR ADDITIONAL INFORMATION, REVIEW THESE LINKS

www.leapfrog.org

Results At One Organization

Things They had in place



Therapeutic Duplication	B-
Drug-Allergy	C+
Drug-Drug Interactions	C (no drug-food)
Normal Order Alerts	A-

Results at One Organization

Things they did not have in place



Corollary Orders	F
Duplicate Test	F
Dose Limits	F
Drug-disease	F
Drug-Lab	F
Wrong route	D-

What They did with the results



- If one looks at our error tracking mechanisms
 - We needed to focus on
 - ✓ Drug dosing
 - ✓ Potentially drug-lab
- Had been thinking about dosing, but no pre-built knowledge base that could easily be used for it.
- Pharmacy review of pre-configured allergy and drug-drug alerts.
- Review of important food allergies (not so easy as you might think...)
- Pharmacy/physician review of important corollary orders.
- Incorporate new functions into our next big re-build of the CPOE system

Conclusions



- Benefits of the test:
 - Makes very transparent the quality of reactive alerts for errors of commission or omission
 - Provides a very nice impetus to get started on fixing up your CDS
 - When linked to public reporting that impetus will be that much stronger
 - Provides a clear set of categories to help plan your CDS improvement strategy

Table 2 Decision support at test sites by category

Category	Number of test sites providing decision support in this category (n = 6)
Therapeutic duplication	3
Single/cumulative dose limits	2 most test orders 2 selected medications
Drug allergy	5
Contraindicated route	3 most test orders 1 selected medications
Drug-drug interaction	5
Drug-diagnosis interaction	0
Drug-laboratory interaction	2
Drug-radiology procedure interaction	0
Corollary orders	3
Cost of care	1



Questions?